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(11) CA 951662

(54) PROCESS FOR PREPARING SUBSTITUTED PHENYLALKANOIC ACIDS

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ABSTRACT:

CLAIMS: [Show all claims](#)

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PROCESS FOR PREPARING SUBSTITUTED PHENYLALKANOIC ACIDS

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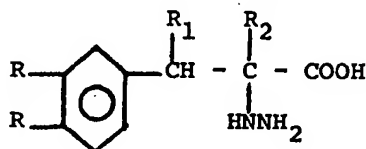
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1 This invention describes a new method of preparing
 2 certain α -hydrazino- β -phenylalkanoic acids and their deri-
 3 vatives. More particularly, it describes a method of pre-
 4 paring L- α -hydrazino- β -hydroxyphenyl alkanoic acids.

5 It is known in the art that various α -hydrazino-
 6 β -phenylalkanoic acids are useful as decarboxylase inhibi-
 7 tors. It is further known that the D-isomer of these acids
 8 is generally inactive and may even be antagonistic to the
 9 action of the L-form, thereby reducing its potency.

10 This invention describes a novel process for the
 11 preparation of the L- α -hydrazino- β -phenylalkanoic acids.

12 The present invention provides a new method of
 13 preparing the L-stereoisomeric compounds of Formula I:



I

14 where

15 R is hydrogen or hydroxy;

16 R_1 is hydrogen or lower alkyl; and

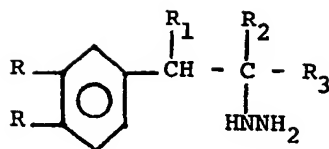
17 R_2 is hydrogen or lower alkyl.

18 It is to be understood that the L-configuration is
 19 in reference to the absolute configuration on the α -carbon
 20 in relation to the hydrazine.

21 We have found that the compounds of Formula I
 22 can be conveniently prepared by microbiological hydrolysis
 23 of the L-stereoisomeric compound of Formula II:



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II

1 where

2 R_3 is loweralkoxy carbonyl,

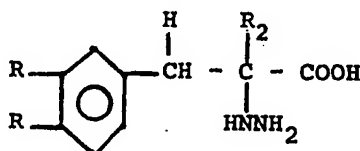
3 amido or

4 cyano; and

5 R , R_1 and R_2 are as described above.

6 We have found that the compounds of Formula II can
7 be contacted with specific enzymes which cause hydrolysis to
8 the desired L-stereoisomeric acid of Formula I and thereby
9 eliminate costly and complicated separation procedures.

10 A more preferred embodiment of this invention
11 describes the preparation of the L-stereoisomeric compound
12 of Formula III:



III

13 where R and R_2 are as described above.

14 A most preferred embodiment of this invention
15 describes the preparation of L- α -(3,4-dihydroxybenzyl)- α -
16 hydrazino propionic acid and L- β -(3,4-dihydroxyphenyl)- α -
17 hydrazino propionic acid.

18 In the above descriptive portions of formulae I -
19 III, the following definitions apply:

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The "lower alkoxy" radical signifies an alkoxy group containing from 1 to about 6 carbon atoms which can be straight chained or branched.

"Aralkoxy" refers to an arylalkoxy group, the aryl portion of which may be one or more phenyl or naphthyl radicals attached to an α -alkoxy radical which contains from 1 to about 4 carbon atoms. The preferable aralkoxy groups are benzyl, diphenylmethyl, trityl, naphthylmethyl and substituted benzyl and the like groups. Such substituents may include lower alkyl
10 such as o-methylbenzyl, lower alkoxy such as 3,4-veratryl and 4,4',4"-trimethoxytrityl and the like.

The present invention may be practiced by intimately contacting an enzyme system capable of hydrolyzing an ester, amide or nitrile compound of Formula II to form the desired acid.

The esters of Formula II may be hydrolyzed to the free acid by a wide variety of enzymatic systems which are capable of selectively hydrolyzing the ester group. Thus, for example, methyl L - α -(3,4-dihydroxybenzyl)- α -hydrazinopropionate
20 may be saponified by pig liver esterase to yield L - α -(3,4-dihydroxybenzyl)- α -hydrazinopropionic acid. Other microorganisms which may selectively hydrolyze the ester compounds of Formula II include *Aspergillus oryzae*, *Zygosaccharomyces aoidifiens*, *Streptomyces spheroides* and *Alcaligenes sp.* These microbiological systems may be used *in situ* or the cell-free broth may be used as the enzyme source. The cells can be used as suspensions in pH 5.0 to pH 9.0 phosphate buffer at levels equivalent to 0.1 to 10% dry weight basis. A cell-free system
30 may be prepared by sonication of the cells followed by centrifugation.

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1 The ester is dissolved in aqueous methanol solu-
2 tion and used at levels such that the final substrate con-
3 centration in the enzyme solution will be between 0.1 to 10%.
4 The final methanol concentration may range from 10 to 30%.

5 The nitriles of Formula II may also be hydrolyzed
6 to the free acid by enzymatic hydrolysis in the presence of
7 a nitrilase. The hydrolysis may be carried out by using
8 nitrilase which is found in the leaves of barley, oats, cab-
9 bage, cauliflower, brussel sprouts, etc. This enzyme has
10 the power to hydrolyze nitriles directly to the carboxylic
11 acids. The nitrilase is extracted with 0.1 M phosphate
12 buffer at pH 7.5 from the leaves of oats or barley. Ten to
13 50 g. are obtained per 100 ml. of buffer. The nitrile and
14 enzymes are dissolved in methanol to give 10 - 20% methanol
15 in the final 0.1 - 10% enzyme-nitrile substrate mixture.
16 Hydrolysis is carried out by stirring at room temperature,
17 keeping the pH at 7 - 8 by the addition of alkali.

18 The amides of Formula II may also be hydrolyzed to
19 the corresponding acid of Formula I through the use of amide-
20 hydrolyzing enzymes. Among those hydrolases that may be used
21 are the deacylases, and the amidases such as urease. The
22 hydrolyzing system may be used as the free enzyme cells or
23 in an enzyme broth suspension of from 0.1 to 10% concentra-
24 tion. The hydrolysis is usually carried out in a pH medium
25 near neutrality but may be carried out at pH 5 - 9 usually
26 with a phosphate buffer. The amide is dissolved in aqueous
27 methanol solution and used at levels such that the final sub-
28 strate concentration in the enzyme solution will be between
29 0.1 to 10%. The final methanol concentration may range from
30 10 - 30%.

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1 If desired two enzymatic reactions may proceed at
2 the same time. Thus, for example, L- α -N¹-acetylhydrazino-
3 α -(3,4-dihydroxybenzyl)propionitrile may be subjected to a
4 nitrilase and an amidase and result in the desired L- α -
5 hydrazino- α -(3,4-dihydroxybenzyl)propionic acid.

6 The following examples are illustrations of this
7 invention. They are intended to representatively show the
8 method of this invention and are not to be construed as
9 limitations thereof.

10 EXAMPLE 1

11 To L- α -(3,4-dihydroxybenzyl)- α -ureidopropionic
12 acid [J. Med. Chem., 7, 379 (1964)] (25.4 g., 0.1 mole) in
13 150 ml. of methanol is added 16.74 g. (0.31 mole) of sodium
14 methyrate. With stirring 23.32 g. (0.2 mole) of benzyl
15 chloride is added dropwise and the mixture refluxed for 4
16 hours. Water (200 ml.) is added and the mixture is dis-
17 tilled until the boiling point reaches 95-98°. By addition
18 of hydrochloric acid the pH of the mixture is adjusted to
19 3.5, the volume adjusted to 200 ml. by addition of water and
20 the mixture refluxed for 2 hours additional. After water is
21 removed in vacuo, the mixture is extracted with methanol and
22 the methanol extract chromatographed over silica gel. The
23 eluate is concentrated to obtain L- α -(3,4-dibenzyloxybenzyl)-
24 α -ureidopropionic acid.

25 To an ice-cold mixture of the hydantoic acid of
26 the previous step (21.78 g., 0.05 mole) in 100 ml. of 2.5 N
27 sodium hydroxide is added to a solution of sodium hypochlor-
28 ite (89.5 ml., 0.70 N, 0.0625 mole). After the addition is
29 completed the mixture is stirred for 5 minutes at 0-5°. The
30 mixture is then heated to 80° and maintained at 80° for 1.5

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1 hours. At the end of this period 300 ml. of toluene and
2 4 ml. of 85% hydrazine hydrate are added and the mixture
3 vigorously agitated while 54 ml. of concentrated hydrochloric
4 acid is added. The mixture is stirred at 80° for 30 minutes,
5 the phases separated and the aqueous phase washed with 150
6 ml. of toluene. The aqueous phase is evaporated to dryness,
7 the residue extracted with methanol and the pH of the extract
8 adjusted to 6.4 with diethylamine. The product is separated
9 by filtration and recrystallized from methanol-water to
10 obtain L- α -(3,4-dibenzyloxybenzyl)- α -hydrazinopropionic acid.
11 To a solution of L- α -(3,4-dibenzyloxybenzyl)- α -hydrazinopro-
12 pionic acid (8.13 g., 0.02 mole) dissolved in 100 ml. of
13 methanol is added hydrogen chloride gas until the saturation
14 point is reached. The mixture is stirred at room temperature
15 (25°) for 24 hours and then evaporated to dryness in vacuo.
16 The residue is crystallized from methanol-water to yield
17 methyl L- α -(3,4-dibenzyloxybenzyl)- α -hydrazino propionate.

18 A solution of methyl L- α -(3,4-dibenzyloxybenzyl)-
19 α -hydrazinopropionate (8.4 g., 0.02 mole) in 200 ml. of
20 acetic acid is hydrogenated over 0.5 g. of 5% palladium on
21 charcoal at room temperature and 3 atm. pressure. The cata-
22 lyst is removed by filtration, washed and the filtrate con-
23 centrated to yield methyl L- α -(3,4-dihydroxybenzyl)- α -hydra-
24 zinopropionate.

25 A solution of methyl L- α -(3,4-dihydroxybenzyl)- α -
26 hydrazinopropionate (9.6 g., 0.04 mole) in 1 l. of 0.01 M
27 potassium chloride was brought to pH 8.0 by addition of
28 potassium hydroxide from a microburet. Approximately 100
29 units of pig liver esterase was added and allowed to act at
30 37°. Potassium hydroxide was added as required to maintain

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1 the pH at 8.0. After 4 hours the pH is adjusted to 6.4 with
2 hydrochloric acid and the mixture concentrated in vacuo to
3 dryness. The residue is extracted with methanol and the
4 methanol extract is concentrated in vacuo to dryness. On
5 recrystallization from water L- α -hydrazinopropionic acid,
6 m.p. 208° dec. is obtained.

7 EXAMPLE 2

8 A solution of methyl L- α -(3,4-dihydroxybenzyl)- α -
9 hydrazinopropionate (9.6 g., 0.04 mole) in 1 l. of 0.01 M
10 potassium chloride is brought to pH 8.0 by addition of
11 potassium hydroxide from a microburet. Approximately 100
12 units of pig liver esterase [J. Am. Chem. Soc., 84, 695
13 (1962)] is added and allowed to act at 37°C. Potassium
14 hydroxide is added as required to maintain the pH at 8.0.
15 After 4 hours the pH is adjusted to 6.4 with hydrochloric
16 acid and the mixture concentrated in vacuo to dryness. The
17 residue is extracted with methanol and the methanol extract
18 is concentrated in vacuo to dryness. On recrystallization
19 from water L- α -hydrazinopropionic acid, m.p. 208°C. dec. is
20 obtained.

21 When methyl L- α -(3,4-dihydroxybenzyl)- α -hydrazino-
22 propionate is replaced in the above example by the compounds
23 of Table I, then the compounds of Table II are prepared.

24 TABLE I

25 methyl L- α -(3-hydroxybenzyl)- α -hydrazinopropionate,
26 methyl L- β -(3,4-dihydroxyphenyl)- α -hydrazinopropionate,
27 methyl L- β -(3,4-dihydroxyphenyl)- α -hydrazinobutanoate,
28 methyl L-(4-hydroxybenzyl)- α -hydrazinopropionate,
29 methyl L- β -(3,4-dihydroxyphenyl)- α -methyl- α -hydrazino-
30 butanoate

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TABLE II

L- α -(3-hydroxybenzyl)- α -hydrazinopropionic acid,
L- β -(3,4-dihydroxybenzyl)- α -hydrazinopropionic acid,
L- β -(3,4-dihydroxyphenyl)- α -hydrazinobutanoic acid,
L- α -(4-hydroxybenzyl)- α -hydrazinopropionic acid,
L- β -(3,4-dihydroxyphenyl)- α -methyl- α -hydrazinobutanoic acid.

EXAMPLE 3

Ethyl L- α -(3,4-dihydroxybenzyl)- α -hydrazinopropionate
is dissolved in aqueous methanol solution and used at levels
10 such that the final substrate concentration in the enzyme
solution will be between 0.1 to 10%.

The system, capable of hydrolyzing the ethyl L- α -
(3,4-dihydroxybenzyl)- α -hydrazinopropionate is selected from
the microorganisms - *Aspergillus oryzae*, *Zygosaccharomyces*
acidifiens, *Streptomyces spheroides* and *Aloaligenes* sp. The
cells or the cell-free broth may be used as the enzyme source.
The cells are suspended in pH 5.0 to pH 9.0 phosphate buffer at
levels equivalent to 0.1 to 10% dry weight basis. The cell-
free system may be prepared by sonication of the cells followed
20 by centrifugation.

The final methanol concentration is from 10 - 30%.

The mixture is stirred at 37°C. for 1 - 6 hours.
Dilute alkali is added periodically in order to maintain the
pH near neutrality. The product is isolated by filtration
from the insoluble material followed by acidification of the
filtrate to pH 1 - 2 with 1 N hydrochloric acid. Concen-
tration *in vacuo* results in crude L- α -(3,4-dihydroxybenzyl)-
 α -hydrazinopropionic acid hydrochloride. The crude acid salt
is adsorbed on Amberlite®-IR-120 on the acid (H_3O^+) cycle.
30 The product is eluted with 1 N ammonium hydroxide, the

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eluate concentrated to dryness *in vacuo* and recrystallized from water containing 0.5% sodium bisulfite to yield the product of this invention, m.p. 208° dec.

EXAMPLE 4

By the procedure of Canadian Patent No. 791,154, July 30, 1968, L- α -3,4-dihydroxy- α -methylphenylalanine is converted successively to L-4(3',4'-diacetoxybenzyl)-2,4-dimethylazlactone, L- α -acetamido- α -3-acetoxy-4-hydroxybenzyl-propionamide and L- α -acetamido- α -(3,4-diacetoxybenzyl)propio-
10 nitrile.

To a slurry of 100 ml. of water, 200 ml. of ether, 36 ml. of concentrated hydrochloric acid and (0.25 mole) of L- α -acetamido- α -(3,4-diacetoxybenzyl)propionitrile at 0-10° is added dropwise with vigorous stirring 18 g. (0.26 mole) of sodium nitrite in 36 ml. of water. The temperature is maintained at 0-10° during addition and during one hour of stirring. The ether layer is separated, the water layer extracted with two 100 ml. portions of ether, the combined ethereal extract is washed with saturated salt solution and
20 the ethereal extract dried (MgSO₄). The mixture is concentrated *in vacuo* to yield L- α -N-acetyl-N-nitroso- α -(3,4-diacetoxybenzyl)propionate.

A mixture of 65.5 g. (1.0 mole) of zinc dust and 100 ml. of water is cooled to 10°. While stirring (0.24 mole) of nitroso compound in 150 ml. of glacial acetic acid is added while maintaining the temperature at 10-15°. After addition is finished the mixture is allowed to warm to room temperature over an hour and then warmed to 80° on the steam bath. The mixture is filtered to remove unreacted zinc, and the precipi-
30 tate washed with three 25 ml. portions of warm 2 N hydro-

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1 chloric acid. The combined filtrate is cooled to room tempera-
2 ture and with cooling basified to pH 6.5. The mixture is
3 filtered and the precipitate dried. The residue is extracted
4 with three 200 ml. portions of chloroform. The dried (MgSO_4)
5 extract is concentrated in vacuo to a residue which is recrystallized
6 from methanol to yield $\text{L-}\alpha\text{-N}^1\text{-acetylhydrazino-}\alpha\text{-(3,4-}$
7 $\text{diacetoxybenzyl})\text{-propionitrile}$.

8 The compound (33.34 g., 0.1 mole) of the previous
9 step is refluxed with 1650 ml. of methanol for 5 hours in the
10 presence of sodium bicarbonate (16.6 g., 0.2 mole). The ice-
11 cold mixture is brought to pH 7.6 with cold 1 N hydrochloric
12 acid and concentrated to dryness in vacuo. The residue is
13 extracted with ethanol, the ethanol extract concentrated to
14 dryness and the residue triturated with isopropyl alcohol to
15 yield $\text{L-}\alpha\text{-N}^1\text{-acetylhydrazino-}\alpha\text{-(3,4-dihydroxybenzyl)propio-}$
16 nitrile .

17 The acetylhydrazinonitrile (12.46 g., 0.05 mole) of
18 the previous step is subjected to an amidase to yield $\text{L-}\alpha\text{-}$
19 $\text{(3,4-dihydroxybenzyl)-}\alpha\text{-hydrazinopropionitrile}$.

20 EXAMPLE 5

21 The nitrilase enzyme used is extracted with 0.1 M
22 phosphate buffer, pH 7.5 from the leaves of oats (Avena),
23 barley (Honderum), the Brassica-family and certain Musaceae.
24 Ten to 50 g. of the material are extracted per 100 ml. of
25 buffer.

26 $\text{L-}\alpha\text{-(3,4-dihydroxybenzyl)-}\alpha\text{-hydrazinoacetonitrile}$
27 is dissolved in a quantity of methanol such that the final
28 concentration of methanol is between 10 - 30% in the enzyme-
29 substrate mixture. The final substrate concentration is kept
30 between 0.1 to 10%. The hydrolysis is carried out at 25 - 37°C.

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1 for 1 - 6 hours. The pH is maintained at 7.0 - 8.0 by the
2 addition of dilute alkali. At the end of this time, the
3 mixture is acidified to pH 1 - 2 with dilute HCl and extracted
4 with chloroform. The aqueous extracts are washed with chloro-
5 form and concentrated in vacuo to dryness leaving a residue
6 of crude L- β -(3,4-dihydroxyphenyl)- α -hydrazinopropionic acid
7 hydrochloride and purified as in Example 3, m.p. 208° dec.

8

9 When L- α -(3,4-dihydroxybenzyl)- α -hydrazinoaceto-
10 nitrile of the above example is replaced by the compounds of
11 Table III then the products obtained are shown in Table I.

12

TABLE III13 L- α -(3-hydroxybenzyl)- α -hydrazinopropionitrile,14 L- β -(3,4-dihydroxyphenyl)- α -hydrazinopropionitrile,15 L- β -(3,4-dihydroxyphenyl)- α -hydrazinobutanonitrile,16 L- α -(4-hydroxybenzyl)- α -hydrazinopropionitrile,17 L- β -(3,4-dihydroxyphenyl)- α -methyl- α -hydrazinobutanoni-
18 trile.

19

EXAMPLE 6

20 20.72 G. (0.1 mole) of L- α -(3,4-dihydroxybenzyl)-
21 α -hydrazinopropionitrile is stirred at 0-5°C. with 200 ml.
22 of 45% hydrochloric acid for 2 hours. With stirring, the
23 mixture is allowed to warm to room temperature, concentrated
24 to dryness in vacuo to obtain L- α -(3,4-dihydroxybenzyl)- α -
25 hydrazinopropionamide.

26

EXAMPLE 7

27 When the nitrile compounds of Example 3 are replaced
28 with the corresponding amide compounds of Table IV and the
29 nitrilase enzyme is replaced with an amide-hydrolyzing enzyme,
30 then the corresponding products of Table I are prepared.

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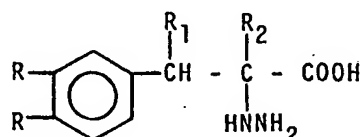
TABLE IV

- 2 L- α -(3,4-dihydroxybenzyl)- α -hydrazinopropionamide,
- 3 L- α -(3-hydroxybenzyl)- α -hydrazinopropionamide,
- 4 L- β -(3,4-dihydroxyphenyl)- α -hydrazinopropionamide,
- 5 L- β -(3,4-dihydroxyphenyl)- α -hydrazinobutanamide,
- 6 L- α -(4-hydroxybenzyl)- α -hydrazinopropionamide,
- 7 L- β -(3,4-dihydroxyphenyl)- α -methyl- α -hydrazinobutanamide.

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process for the preparation of the L-stereoisomeric compound of the formula:



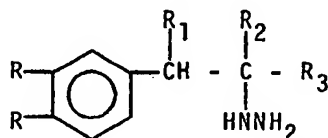
where

R is hydrogen or hydroxy;

R₁ is hydrogen or lower alkyl; and

R₂ is hydrogen or lower alkyl

which comprises hydrolyzing in a suitable medium at a pH of 5 to 9 the L-stereoisomeric compound of the formula:



where

R₃ is loweralkoxycarbonyl,

amido or

cyano; and

R, R₁ and R₂ are as described above,

by intimately contacting with a hydrolytic enzyme system selected from an esterase which is selected from pig liver esterase or a microorganism selected from *Aspergillus oryzae*, *Zygosaccharomyces acidifiens*, *Streptomyces spheroides* and *Alcaligenes* sp., an amide-hydrolyzing enzyme selected from deacylase and urease, and a nitrilase.

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2. A process according to Claim 1 where

R is hydroxy,

R₁ is hydrogen and

R₂ is hydrogen

thus forming L-β-(3,4-dihydroxyphenyl)-α-hydrazinopropionic acid.

3. A process according to Claim 1 where

R is hydroxy,

R₁ is hydrogen and

R₂ is methyl

thus forming L-β-(3,4-dihydroxyphenyl)-α-methyl-α-hydrazinopropionic acid.

4. A process according to Claim 2 or 3 where R₃ is loweralkoxycarbonyl and the hydrolytic enzyme system is an esterase selected from pig liver esterase or a microorganism selected from *Aspergillus oryzae*, *Zygosaccharomyces acidifiens*, *Streptomyces spheroides* and *Alcaligenes* sp.

5. A process according to Claim 2 or 3 where R₃ is amido and the hydrolytic enzyme system is an amide-hydrolyzing enzyme selected from deacylase and urease.

6. A process according to Claim 2 or 3 where R₃ is cyano and the hydrolytic enzyme system is a nitrilase.

ABSTRACT

A new method of preparing L- α -hydrazino- β -phenyl-alkanoic acids by enzymatic hydrolysis of the corresponding esters, amides and nitriles is disclosed. The esters are hydrolyzed by using an esterase such as pig liver esterase or a microorganism selected from *Aspergillus oryzae*, *Zygosaccharomyces acidifiens*, *Streptomyces spheroides* and *Aloaligenes* sp. The amides are hydrolyzed by using an amide-hydrolyzing enzyme selected from deacylase and urease while the nitrile is hydrolyzed by using nitrilase.

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